To: USPTO

Art Unit 1631

Response To Detailed Action Comments, Date Mailed: 9/22/2006

A. Regarding the USPTO rejections per 37 CFR 1.75(c) of claims 22-25, and 29-30, the claims are herein amended to resolve their being of improper dependent form.

B. Regarding the USPTO rejections per 35 U.S.C. 112 of claims 40 and 42, the claims are herein amended to specify their metes and bounds.

C. 1. The USPTO has issued rejections per 35 U.S.C.101 of claims 1-21, 26-28, 33-36, 40-42, 44, 48-52, 54-55, 58-59, 62-64, 66, and 68, because, "In the absence of the hand of man, the naturally occurring products are considered non-statutory subject matter….", and,

C.2. The USPTO has issued rejections per 35 U.S.C.102 of claims 1-14, 17-21, 26-27, 33, 44, 48, 51-52, 54-55, 58-59, 62, 64, and 66-68 because they were anticipated by Fujime [Journal of the Physical Society of Japan, 1970, volume 29, pages 416-430], (Tobacco Mosaic Virus), and,

C.3. The USPTO has issued rejections per 35 U.S.C.102 of claims 1-14, 17-21, 26-27, 33, 44, 48, 51-52, 54-55, 58-59, 62, 64, and 66-68 because they were anticipated in light of Namba, et al, [Journal of Molecular Biology, 1989, volume 208, pages 307-325 (Tobacco Mosaic Virus).

To briefly summarize, the USPTO asserts that the tobacco mosaic virus cited above in C.2 and C.3 is naturally occurring and has structural features similar to natural clathrin protein. The instant invention utilizes the clathrin protein. C2 and C3 also make reference to the use of laser generated photons and X-ray fiber diffraction, respectively. The instant clathrin-based invention is also a laser and source of photons. The USPTO asserts that the tobacco mosaic virus thus has some structural and functional utility in common with the clathrin-based invention. The USPTO therefore says **C2** and **C3**

anticipate the instant invention, a novel bio-based laser and source of regulated photons that also has utility in quantum information processing.

The inventors of the instant invention dispute the USPTO's rejection of claims listed in **C1, C2, and C3,** because, in fact, the listed claims relate to non-naturally occurring systems and are the result of the hand of man. For example, the terms "purified", and "bio-engineered," and their obvious synonyms like "man-made" and "non-naturally occurring" are repeatedly referenced in the instant invention specification, as well as in the amended claims, commencing in amended claim 1. References re non-naturally occurring appear in the instant patent specification, some of which are enumerated and highlighted below:

0014 "... According to another feature, **the proteins that form the cage can be bio-engineered using commercially-available biotechnology tools** to contain different cargo elements, which makes the invention more versatile and cost-effective than the existing art."

"**0057** Cage 106 can be naturally occurring or **biologically engineered and/or can use synthetic proteins in whole or in part.** Also, the receptor molecules 104a-104f can be naturally occurring or **biologically engineered and/or can use synthetic proteins in whole or in part** to recognize specific cargo elements 102a-102f. Likewise, the adapter molecules 108a-108f can be naturally occurring or **biologically engineered and/or can use synthetic proteins in whole or in part** to recognize and couple to particular receptor molecules 104a-104f. "

"**0082** As mentioned above, naturally in vivo occurring clathrin cages 106 assemble around membranes to form vesicles. Referring again to Figure 1, the adapter molecules 108a-108f couple clathrin proteins 106a-106f to receptor molecules 104a-104f disposed around the periphery of the vesicle 110. **According to the illustrative embodiment, the clathrin cage 106 is formed around the vesicle 110 *in vitro* using synthetic, natural, or mixed lipid monolayers or bilayers and purified receptor 104a-104f and adapter 108a-108f molecules.** For example, in one illustrative embodiment, **the clathrin cage 106 is formed by adding biologically engineered clathrin proteins 106a-106f and adapter molecules 108a-108f, such as AP-2 and**

AP180, to a PIP2-containing lipid monolayer. According to one feature of the invention, **the receptor molecules 104a-104f are biologically engineered** to recognize and associate with specific molecules that serve as the cargo elements 102a-102f. According to another feature, the **adapter molecules 108a-108f are biologically engineered** to recognize specific receptor molecules 104a-104f and couple the receptor molecules 104a-104f to the clathrin cage 106."

"**0084** Below pH 6.5, **purified clathrin triskelions self-assemble *in vitro*** into a polyhedral lattice (cages) without vesicles, but typically only form cages at physiological pH in the presence of **stoichiometric quantities of purified AP-1 or AP-2 adaptor molecules or the neuron-specific assembly proteins AP-180 and auxilin.** Recombinant hubs, formed from residues 1074–1675 of the clathrin heavy chain, are trimeric structures that reproduce the central portion of the three-legged clathrin triskelion, extending from the vertex to the bend in each leg, comprising the binding sites for clathrin light-chain subunits. Without light-chain subunits, recombinant hubs self-assemble reversibly at physiological pH, while hubs with bound light chains self-assemble below pH 6.5, similar to **purified clathrin. Inhibition of hub assembly by light-chain subunits is a key to controlling spontaneous clathrin self-assembly at physiological pH. The mean curvature of baskets (cages without vesicles) is adjustable by the pH level and by other environmental conditions. As can be deduced from the formation of the microcages, a clathrin network can have such a pH-controlled curvature, even in the absence of a membrane bilayer**. In addition, a conserved negatively charged sequence of three residues (23–25) in the clathrin light-chain subunits regulates the pH dependence of hub assembly. Also, two classes of salt bridge (high affinity and low affinity bridges) play a dominant role in driving clathrin assembly. Basket closure depends on the presence of TDD domains (terminal and distal domains). A connection between the proximal and distal domains is not required for curvature, and the TDD themselves can orient the assembling hubs in a favorable angle for polyhedron formation."

"**0086** The heat shock cognate protein, hsc70, helps to regulate the endocytosis aftermath of CCV uncoating and disassembly. In cells overexpressing ATPase-deficient

hsc70 mutants, uncoating of CCVs is inhibited in vivo. In a preferred embodiment, an over expression of **ATPase-deficient hsc70 mutants may be applied and hsc70 mutants additionally modified via bioengineering techniques** to inhibit both CCV and non-vesicle cage disassembly, thereby maintaining CCV and clathrin cage integrity in the invention over prolonged periods of time in vivo and in vitro."

"0092 Bovine clathrin heavy chain cDNA encoding heavy chain amino acids 1-1074 (SEQ ID NO: 1) is cloned into the pET23d vector (Novagen) between the NcoI(234) and XhoI(158) sites. Expression of the cloned sequence results in a terminal and distal domain fragments having a C-terminal polyhistidine tag. Hub fragments corresponding to amino acids 1074-1675 (SEQ ID NO: 2) are cloned into vector pET15b (Novagen) between the BamHI(319) and XhoI(324) sites. Expression of the hub fragments produces the proximal leg domain and central trimerization domain of the clathrin hub with an N-terminal polyhistidine tag. Vectors containing the heavy chain and hub domains **are expressed in *E. coli* by induction with 0.8 mM isopropyl-B-D-thiogalactopyranoside for 3 hours at 30 degrees Celsius. Expressed proteins** are **purified** from bacterial lysate in binding buffer (50 mM Tris-HCl (pH7.9), 0.5M NaCl, 5 mM imidazole) in a nickel affinity resin using the polyhistidine tag. **Proteins are eluted with 100 mM EDTA and dialyzed against 50 mM Tris-HCl (pH7.9). Hub fragments are further purified using size exclusion chromatography on a Superose 6 column (Pharmacia).**"

"0127 Using the universal quantum gate, the quantum processor 602 can perform quantum calculations. Further, because the QIP element 100 is formed using a bioengineered protein, the cage 106 is highly scalable. For example, in some illustrative embodiments, multiple cages 106 may be physically linked via molecular addends, but are not limited to such addend types. In other illustrative configurations, multiple cages 106 may be **functionally linked** via **photonic**, chemical, electromagnetic, electrical and/or quantum (non-classical) interactions, to work and cooperate locally and/or remotely.

In sum, the instant invention requires the hand of man to exist. It further has novel utility as a quantum information processing element and also has utility as a controllable

laser and source of regulated photons. In addition, the instant inventors have specified in a number of instances in the instant application specification and herein amended claims terms such as "purified", and "bio-engineered," "man-made" and "non-naturally occurring." To someone or a person who had ordinary skill in the art it is clear that the constituent components of the instant invention are fundamentally non-equivalent to the all-natural materials cited in C2 and C3, above.

Finally, perhaps the most fundamental inaccuracy in the USPTO's rejection comes regarding Fujime (C2) and his use of an external laser with the tobacco mosaic virus. The methodology described by Fujime is a two-component system, in which there is a separate outside laser light source that is beamed through a tobacco mosaic virus. In marked contrast, the instant invention is a *unitary* laser system. It is a single component. Coherent laser light originates from inside the clathrin protein-caged vesicle, itself. This unitary feature therefore makes the instant invention's operating characteristics and its utility distinctly different from the Fujime-described 2-part setup. Also, Fujime's laser was used to invoke and examine quasi-elastic light scattering from solutions of molecules. Thus, Fujime's laser-virus apparatus intentionally provokes light scattering; just the opposite effect of the instant invention, which intentionally produces coherent light.

On the other hand, Namba et al (C3) do not utilize lasers. Instead, Namba employs X-ray diffraction to elucidate the structure of the tobacco mosaic virus. But quite confusingly, when discussing Namba as the reason for rejecting claims in the instant invention, the USPTO says… "The virus blocks the light radiation in a way to cause the virus to affect radiation using its cage and vesicle. The virus is interpreted as a framework of cages self assembling to form a light source. The laser is a stimulus external to the cage that to which the virus, its cavity, and its cage responds."

Strictly per the cited Namba reference, what the USPTO states is impossible, as Namba is using X-ray diffraction from oriented gels, not laser generated photons. But if the USPTO is stating that Namba's tobacco virus setup could so respond if he were to

use lasers instead of X-rays, then the USPTO's line of reasoning lies in the realm of conjecture, with no basis in science or fact.

D.1. Re the following USPTO rejections:

I. Per 35 U.S.C.101 of Claims 1-42, 44, 47-52, 54-55, 58-59, 62-64, and 66-68 "....because the claimed invention is not supported by either a specific asserted utility or a well established utility....it is unclear how someone skilled in the art would use a laser light source or method of making a laser light source for the purpose of solving a quantum mechanics or any mathematical calculation.", and,

II. Per 35 U.S.C.101 of Claims 1-42, 44, 47-52, 54-55, 58-59, 62-64, and 66-68, because Lee, et al "shows usage of quantum dots in viruses but does not show how such particles can be used in quantum mecahnical (sic) calculations.", and,

III. Per 35 U.S.C.112, first paragraph, of claims 1-42, 44, 47-52, 54-55, 58-59, 62 64, and 66-68, because, "...Specifically, since the claimed invention is not supported by either a specific asserted utility or a well established utility for the reasons set forth above, one skilled in the art would not know how to use the claimed invention."

Firstly, re item D.I., in the instant application specification, it specifically asserts: "**0070** In one illustrative embodiment, highly controllable ARC nanolasers, droplet based and/or photonic-based, are a regulated source of photons for use in quantum computing and quantum cryptography."

Secondly, re D.II, there is some confusion in the argument for claims rejection by the USPTO. In the present instance, the USPTO says that Lee, et al [Science, volume 296, May 3, 2002, pages 892-896] does <u>not</u> show how photon-emitting particles like quantum dots can be used in quantum mechanical calculations, i.e., they are not programmable. But yet in its other communications to the instant inventors the USPTO apparently asserts such particles can be programmable.

Specifically, in its instant rejection of claims under 35 U.S.C.101, the USPTO states, "For example, Lee, et al shows usage of quantum dots in viruses but does not show how such particles can be used in quantum mecahnical (sic) calculations." However, and rather confusingly, in its Office Action Summary issued in response to the instant inventors' communication of April 24, 2006 regarding their other pending patents #10/661/465 and #10/661/466, the USPTO said that Lee, above, "...shows how the quantum dots are programmable by the use of a magnetic field...Thus the virus affects the magnetic radiation experienced by the quantum dots." It would appear that the USPTO has taken a contradictory stance in its claim rejections, using the same cited references.

D.2. Collectively, items D.1, D.II, and D.III are disputed by the instant inventors, because in truth, the instant patent specifically describes how photons can be used in quantum computing, and which is also expressed in the amended claims via the terms "resulting in controlled lasing", "calculatedly", "artificially configured", "by human design", "non-naturally occurring light source", and such. For example, in the instant patent specification it states:

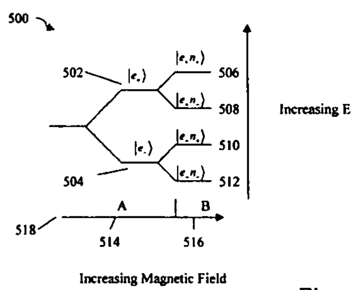

Figure 5

"**0104** By way of example, if a qubit is initially in some state representing $|0\rangle$ 504, a NOT operation can be performed by <u>**shining a pulse of light of appropriate wavelength on a qubit**</u> atom to force an electron to change energy levels. Thus, an electron initially in the ground state absorbs energy from the <u>**light pulse**</u> and is excited to the higher energy state. The wavelength of the applied light pulse must at least match the energy difference between the two energy levels separating the

logic states (i.e., between the ground state and the excited state of the nitroxide) as governed by Planck's quantization law.

$$E = \frac{hc}{\lambda}$$

where

E = energy difference between energy levels of orthogonal quantum logic states

h = Planck's constant

c = the speed of light, and

λ = wavelength of the applied pulse.

If the pulse exceeds the energy required for excitation, the extra energy is emitted as a **photon** after the electron reaches the higher energy level, i.e., $|1\rangle$."

"**0105** In a further illustrative embodiment, an applied magnetic field interacts with the electron spin, but not with the nuclear spin, i.e., in the A region 514. This configuration gives rise to two one-qubit states using spin $|0\rangle$ 502, $|1\rangle$ 504. The NOT operation in this configuration involves changing the direction of the applied magnetic field 518. In one illustrative embodiment, the electron is excited using pulses of electromagnetic radiation while maintaining its spin configuration. The source of the electromagnetic radiation may be, for example, an ordinary lamp, an LED, a time-varying magnetic field generator, **a laser**, or an electromagnetic field generator. In the illustrative embodiment, the electromagnetic source acts as a writing element."

D.3. The USPTO rejection of Claims 1-42, 44, 47-52, 54-55, 58-59, 62-64, and 66-68 under 35 U.S.C. 101 also states that "Substantial research is necessary to use light as a means of satisfying the utilities in the instant specification." Currently, there are hundreds, if not thousands of scientific papers describing utility in the area of quantum computing and using lasers and photonics. For someone or a person skilled in the art of quantum computing using optics, photons, quantum dots, and lasers, the benefit of the instant invention, a nanoscale tunable dye laser, is obvious, and its novel utility will bring significant value to the art.

Attention is drawn to eight exemplar scientific papers that were sent on Sept. 6, 2006 to the USPTO and incorporated as reference to the instant application. They are all attached once again with this reply. They are also listed on a separate Information Disclosure Statement, attached. The eight papers' titles are:

1. A Neutral Atom Quantum Register
W. Alt,Y. Miroshnychenko, A. Rauschenbeutel and
I. Dotsenko, M. Khudaverdyan, D. Meschede, D. Schrader
Institut für Angewandte Physik der Universität Bonn, 2004

2. Coherently Manipulating Two-Qubit Quantum Information Using A Pair Of Simultaneous Laser Pulses
L. F. Wei, and F. Nori,
Europhys. Lett., 65 (1), pp. 1–6 (2004)
DOI: 10.1209/epl/i2003-10053-y, Europhysics Letters

3. Control and Measurement of Three-Qubit Entangled States
Christian F. Roos, Mark Riebe, Hartmut Haffner,
Wolfgang Hansel, Jan Benhelm, Gavin P. T. Lancaster,
Christoph Becher, Ferdinand Schmidt-Kaler, Rainer Blatt
4 June 2004 Vol 304 Science

4. Laser Addressing Of Individual Ions In A Linear Ion Trap
H. C. Nagerl, D. Leibfried, H. Rohde, G. Thalhammer, J. Eschner, F. Schmidt-Kaler, and R. Blatt
Physical Review A Volume 60, Number 1 July 1999

5. Perfect Quantum Error Correction Coding In 24 Laser Pulses
Samuel L. Braunstein
John A. Smolin (August 28, 2006)
arXiv:quant-ph/9604036 v2 22 Oct 1996

6. Quantum Computation with Ultrafast Laser Pulse Shaping
Debabrata Goswami
Resonance, June 2005

7. Speed Optimized Two-Qubit Gates with Laser Coherent Control Techniques for Ion Trap Quantum Computing
J. J. Garcıa-Ripoll, P. Zoller, and J. I. Cirac
Volume 91, Number 15, Physical Review Letters, 10 October 2003

8. Weak Nonlinearities: A New Route To Optical Quantum Computation
W J Munro, K Nemoto and T P Spiller

New Journal of Physics 7 (2005) 137, 27 May 2005

D.4. Re D.I-D.III, additional references to optics, quantum dots, regulated photons, and their relevance to quantum computing may also include the following, which are all attached in full text form with this reply and are also listed on a separate Information Disclosure Statement, attached, as references to the instant application specification:

- Alivisatos, AP, Semiconductor Clusters, Nanocrystals, and Quantum Dots, Science, pp. 933-937, 1996
- Artemyev, M. V. Woggon, Quantum Dots In Photonic Dots, Applied Physics Letters, 2000
- Brown, K.R., D. A. Lidar, and K. B. Whaley, Quantum computing with quantum dots on quantum linear supports, Physical Review A, Volume 65, 2001
- Debray, P. et al. Ballistic Electron Transport In Stubbed Quantum Waveguides: Experiment And Theory. Phys. Rev. B 61, 10950±10958 (2000).
- Harneit, W., Fullerene-Based Electron-Spin Quantum Computer, Physical Review A, Volume 65, 032322, Received 11 October 2001; Published 27 February 2002
- Michler, P., Kiraz, A., A Quantum Dot Single-Photon Turnstile Device, Science, Dec. 2000
- Knill, LaFlamme, Milburn, Efficient Linear Optics Quantum Computation, Nature 409, 46, 2001)
- Michler, P., A. Imamo, M. D. Mason, P. J. Carson, G. F. Strouse, S. K. Buratto, Quantum Correlation Among Photons From a Single Quantum Dot at Room Temperature, Nature, August 2000
- Ralph, T.C., A. G. White, W. J. Munro, and G. J. Milburn, Simple scheme for efficient linear optics quantum gates, Physical Review A, Volume 65, December 2001
- Report of the NSF Workshop, Quantum Information Science, An Emerging Field of Interdisciplinary Research and Education in Science and Engineering, October 28-29, 1999 Arlington, Virginia
- Santori, Fattal, Vuckovic′, Solomon; Indistinguishable Photons From A Single-Photon Device, Letters to Nature, 2002; Yamamoto Quantum Entanglement Project, ICORP, JST, E. L. Ginzton Laboratory, Stanford University).

D.5. Regarding items D.I and D.III, as a matter of USPTO patent precedent attention is drawn to the following patents that teach quantum computing using photons (although these teachings employ distinctively different photon source methodologies than the instant invention), and are also listed on a separate Information Disclosure Statement, attached:

7,113,967, "Efficient quantum computing operations", Cleve, et al. September 26, 2006, whose specification states, "Other examples of qubits include quantum dots, linear quantum optics plus single photon detectors, neutral atoms in optical lattices, electrons flowing on Helium, surface acoustic waves and silicon-based proposals."

7,113,598, "Methods and systems for high-data-rate quantum cryptography", Flusberg, et al., September 26, 2006, which among its claims is, "...a photon supplying system capable of supplying a plurality of substantially single photons spaced apart in time; ..."

7,019,875, "Method and apparatus for single-photon source and quantum memory", Pittman, et al., March 28, 2006, whose abstract states, "An optical switch and optical storage loop are used as the basis of a single-photon source and a quantum memory for photonic qubits..."

6,819,474, "Quantum switches and circuits", Beil, et al. November 16, 2004, whose abstract states, "Quantum switches, referred to as trisistors, operate on the basis of interactions between two elementary particles (EP), such as <u>photons,</u> electrons, phonons, etc."

6,678,450, "Optical method for quantum computing", Franson, January 13, 2004, whose abstract states, "An optical method for quantum computing that makes use of nonlocal effects to construct the quantum gates themselves. A nonlocal interaction in which pairs of atoms interchange two photons produces a large nonlinear phase shift. These nonlinear phase shifts are used to construct quantum logic gates, such as a Controlled-NOT."

5,940,193, "General purpose quantum computing", Hotaling, et al August 17, 1999, whose abstract states, "Method and apparatus are provided for a general purpose photonic computer. A data signal is input through an encoder to encode such signal with an instruction. The encoded signal is transmitted by means of a laser beam to an input buffer where it interferes with a reference beam so as to

form an interference pattern therein as a hologram...Thus the present invention teaches a novel exploitation of photon-induced, quantum-mechanical spin transitions in spin media."

5,838,436, "Multi-purpose quantum computing", Hotaling , et al. November 17, 1998, whose abstract states, "Method and apparatus are provided for a general purpose photonic computer...Thus the present invention teaches a novel exploitation of photon-induced, quantum-mechanical spin transitions in spin media."

D.6. Critically, the teachings of Fujime and Namba (C.2 and C.3) do not in any way describe a non-naturally occurring tunable dye laser light source that utilizes the fundamental physics of ARC lasers (see below).

D.7. Regarding items D.I and D.III, there is the essential matter of the specification being clear enough that someone or a person skilled in the art can make and use it. These issues are succinctly and clearly addressed in the instant specification, wherein it states:

"**0063** The Q factor within the microsphere or nanosphere remains high up to a critical deformation and then decreases rapidly. Beyond this critical deformation, the laser light emission from the deformable microcavity or nanocavity becomes highly directional and controllable. This ray optics model for deformable droplets has evolved to generally describe the spoiling of the high-Q (whispering gallery) modes of deformable ring-shaped cavities as they are deformed from perfect circularity. A sharp threshold has been found for the onset of Q-spoiling as predicted by the KAM theorem of non-linear dynamics. Beyond a critical deformation the escaping light emerges in certain specific directions that may be predicted. The deformations considered can be quite large, ranging from 1-50% of the undeformed radius, assuming that they maintain the convexity of the cavities. Such "asymmetric resonant cavities" (ARC) possess unique advantages, such as:

1. The ability to tune the Q-value and resonant frequency of the ARC by appropriate

deformations.

2. When deformed in situ, designing a Q-switched ARC laser.
3. The ability to couple a high-Q/WG mode out of the ARC with strong directionality."

D.8. Regarding items D.I and D.III, the fundamental physics of ray chaos and Q-spoiling in lasing droplets and ARCs is well understood by someone or a person skilled in the art, as per the following exemplar references, which are all attached in full text form with this reply, and are also listed on a separate Information Disclosure Statement as references, attached, to the instant application specification:

- Brun, T., Wang. H., Coupling Nanocrystals To A High-Q Silica Microsphere: Entanglement In Quantum Dots Via Photon Exchange, arXiv:quant-ph/9906025
- Liang, W., M, Bockrath, D. Bozovic, J. Hafner, M. Tinkham & H. Park, Fabry-Perot Interference In A Nanotube Electron Waveguide, Letter to nature, Nature, Vol. 411, 7 June 2001
- Mekis, A., J. U. Nockel, G. Chen, A. D. Stone and R. K. Chang, Ray chaos and Q-spoiling in Lasing Droplets, Phys. Rev. Lett. 75, 2682 (1995)
- Nockel, J. U., A. D. Stone and R. K. Chang, *Q*-spoiling and Directionality in Deformed Ring Cavities, Optics Letters 19, 1693 (1994)
- Nockel, Jens., A. Douglas Stone, Chaotic Light: A Theory Of Asymmetric Resonant Cavities Arxiv:Physics/0203063 V1 21 (Mar 2002)

The application of this particular area of fundamental physics in the instant application is novel and brings practical utility to the art. This special utility is characterized in the amended claims, which use the terms "controlled lasing", "calculatedly", "artificially configured", "by human design", "purposely enhance", "non-naturally occurring light source", and such. A functional description also appears in the instant application specification:

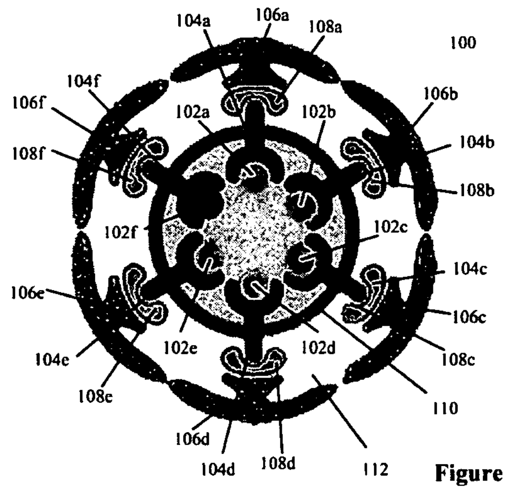

Figure 1

"**0064** In one illustrative ARC nanolaser embodiment, a dyed droplet with or without additive scattering particles is carried within cargo elements 102a-102f that are designed to be cavity forming and non-permeable, and/or the droplet is carried within a cavity forming, non-permeable vesicle 110 within cage 106. Forces, for example, photonic, mechanical, fluidic, thermal, sonic, or electromagnetic, but not limited to such, deform the cavity forming cargo elements 102a-102f and/or deform the cavity forming vesicle 110 within the cage 106. Accordingly, the dyed droplet carried within the cavity deforming cargo elements 102a-102f and/or carried within cavity deforming vesicle 110 is also deformed, and the so deformed droplet becomes a deformable high-Q optical resonator. Photons resonate within the deformed droplet cavity carried inside cargo elements 102a-102f and/or carried inside within the vesicle 110 within the clathrin cage 106. At critical deformations that tune the Q-value and resonant frequency of the droplet cavity, lasing occurs, and stimulated light emissions from the droplet are released in a highly directional and controlled manner from the droplet and escape from vesicle 110, and or escape from cargo elements 102a-102f, and or escape from cage 106."

E.1 As a general statement re items **C1-C3**, above, the USPTO's attention is drawn to these references in the instant invention specification:

"**0004** The superposition or "coherence" state of a qubit is difficult to maintain because interactions with the surrounding environment cause the qubit to rapidly decay into a classical or "decoherent" state, which destroys the qubit's ability to perform computations. Therefore, **a primary obstacle to building a viable quantum computer is maintaining the qubit in its coherent state long enough to do useful work.**"

"**0014** A further advantage of the invention is that it **provides a structure that maintains quantum coherent states long enough to do useful work**. In addition, the invention can maintain quantum coherent states at room temperature, which eliminates the need for elaborate cooling mechanisms."

"**0034** In general, in a further aspect, the invention is directed to a method of forming a QIP element, including the steps of forming *in vitro* from self-assembling protein molecules, such as clathrin molecules, a cage defining a cavity, and locating one or more cargo elements within the cavity. **In one embodiment, the method includes locating at least one qubit, programmable into a plurality of logical states**, within the cavity."

E.2. In marked contrast to the above text from the instant application specification, Fujime and Namba do not teach that the natural Tobacco Mosaic Virus is capable of maintaining qubits in a coherent state long enough to do useful work, but which capability is expressed in the amended claims, e.g., see amended claim 1, and is also specified in the instant invention. Critically, environmental interactions effectively prohibit the utility of naturally occurring Tobacco Mosaic Virus as a quantum information processing system.

Furthermore, neither Fujime nor Namba teach that Tobacco Mosaic Virus can ever enable quantum information processing, a capability which is expressed in the amended claims and specified in the instant invention.

Lastly, and perhaps most fundamentally, the Tobacco Mosaic Virus teachings of Fujime and Namba do not any way describe a tunable dye laser based on the physics of ARC lasers.

E.3. In sum, absent any specific teachings in Fujime and Namba, above, as to how a quantum computer element and/or tunable ARC nano-laser light source could be built

using their respectively described bio-materials, plus the authors' failure to show an ability for the tobacco virus to maintain quantum coherence, the USPTO has posited its own speculative extrapolation. Absent any basis in science, fact, or demonstrable utility per the cited references, it was simply speculation on the part of the USPTO to reject in the instant application the claims as listed in **C2-C3**, above. In contrast, the original specification and the amended claims make clear the unique utility of the instant invention.

E.4. Along similar lines, the USPTO reasoning for rejecting a number of claims per items **C2-C3**, above, is also fallacious; because it asserts that similar structures (i.e., having the same morphology) that follow similar laws of physics equates to these structures having identical utility and functionality. This is simply not true.

E.g., the energy generated by a naturally occurring waterfall is due to gravity and follows the formula, $E = mgh$, where g is the acceleration due to gravity. This same formula is functionally harnessed by water pouring though a hydroelectric facility. However, absent the hand of man, no one would reasonably claim that a natural waterfall has the same functionality and utility as a hydroelectric facility. Simply having a waterfall in an area does not mean it also produces useful work and can light up a nearby town.

Similarly, simply having a naturally occurring tobacco mosaic virus (or even an adenovirus, bacteriophage, or clathrin in a test tube, and/or quantum dots suspended in a genetically engineered virus) does not mean that, although they are bound by and can be made to respond to the same natural laws of the universe, including quantum mechanics, they can do useful work and act as a **human-controllable** quantum information processing system and/or as a controlled source of photons, as is expressed in the instant invention specification and in the amended claims, like claim 1, and also in other claims containing terms like "offering precise control", "calculatedly", "artificially configured", "by human design", "non-naturally occurring light source", and such.

Thus, as was stated in the instant patent specification:

"**0012** The invention, in one aspect, **remedies the deficiencies of the prior art** by providing a nanoscale quantum information processing (QIP) element, which may be

employed in a scalable quantum information processing platform. A platform according to the invention may be used for example in quantum computing, quantum networks, and quantum cryptography."

"**0032** In general, in another aspect, the invention features a scalable QIP platform that includes one or more embodiments of the QIP elements described above. Preferably, the scalable QIP platform also includes **an encoder** for programming the qubits of at least a subset of the quantum processing elements, and **a decoder** for reading information from the qubits of at least a subset of the quantum processing elements."

"**0035** In general, in another aspect, the invention is directed to a method of forming a scalable quantum information processing platform, including the steps of providing one or more embodiments of the QIP elements described above, **programming the qubits included in one or more QIP elements using an encoder, and reading information from the QIP elements using a decoder."** [See also QIP photonic references in sections D.3 and D.4.]

E.5. Furthermore, **none** of the above USPTO cited references in **C2-C3, above**, discuss concrete implementation details as to how the various cited authors would construct an actual quantum computer that has novel utility. In marked contrast, below are just several how-to examples from the instant patent specification [See also QIP photonic references in sections D.3 and D.4]:

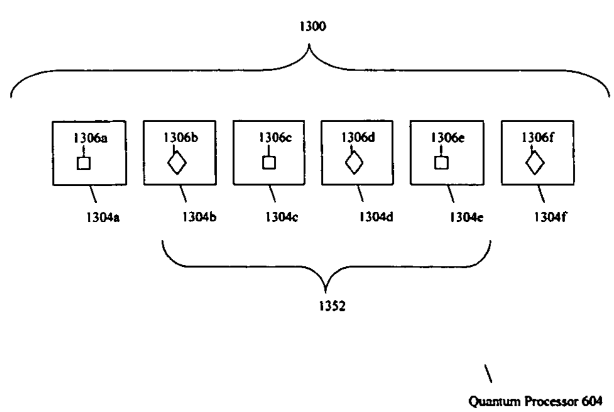

Figure 13

"**0134** Figure 13 is a conceptual diagram depicting a chain of clathrin cages within the quantum processor 602 of Figure 6. In one illustrative embodiment, the quantum processor 602 includes a chain 1300 of QIP elements 1304a-1304f enclosing cargo elements 1306a-1306f, respectively, of two different quantum states. In particular, the quantum processor 602 utilizes a small number of identifiable spins placed in a regularly spatial pattern. The first 1304a, third 1304c, and fifth 1304e QIP elements each have a respective first 1306a, third 1306c, and fifth 1306e cargo element. The second 1304b, fourth 1304d, and sixth 1304f QIP elements each have a respective second 1306b, fourth 1306d, and sixth 1306f cargo element. The first 1306a, third 1306c, and fifth 1306e cargo elements are also collectively referred to below as an A molecule. Similarly, the second 1306b, fourth 1306d, and sixth 1306f cargo elements are also collectively referred to below as a B molecule. In one illustrative embodiment, utilizing a quantum cellular automata quantum computing architecture, but the invention is not limited to utilizing such architectures, the A and B molecules 1306a-1306f have different, identifiable spin species, and for example, the A and B molecules respectively may correspond to a distinctive chemical variant of a nitroxide molecule. In one illustrative embodiment, either the nuclear spin or the electron spin of the A and B molecules represent qubits. In the illustrative embodiment, the QIP elements 1304a-1304f are arranged in alternating linear patterns such that the molecules form a chain configured alternatively, e.g., ABABAB."

"**0132** The quantum computer 600 manipulates the quantum information encoded in this spin chain 1300 via global addressing techniques. Thus, in one illustrative embodiment, a qubit is encoded into four spin sites of the cargo elements 1306a-1306f with a buffer space of four empty spin spites between each logical qubit."

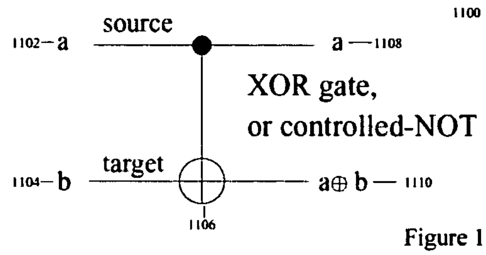

Figure 11

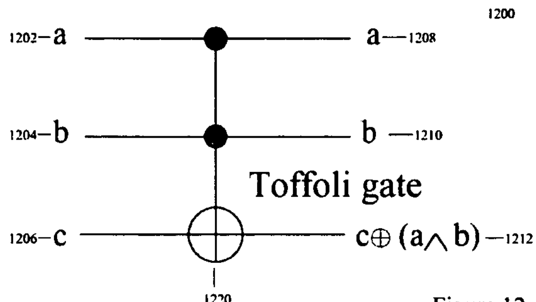

Figure 12

0133 To create the quantum gates of Figures 11 and 12, a unitary operator $\hat{A}\frac{U}{f}$ is first realized. Denoting the spin upstate as $|1\rangle$ and the spin down state as $|0\rangle$, $\hat{A}\frac{U}{f}$ is the conditional application of the unitary U to the A qubits in the alternating qubit chain 1300 ABABAB, depending on the state of A's neighboring B qubits. In a preferred embodiment, the qubits are represented by spin states. Regarding $\hat{A}\frac{U}{f}$, f is the sum of the states of the neighboring B spins. Regarding $\hat{B}\frac{U}{f}$, f is the sum of the states of the neighboring A spins. Thus, if $f = 1$, $\hat{A}\frac{U}{1}$ is the conditioned application of U to all A spins in the alternating chain 1300 which have neighboring B spins that are different from each other. In one embodiment, the I/O module 602 sequences the application of $\hat{A}\frac{U}{f}$ and $\hat{B}\frac{U}{f}$ to generate the single qubit operations and the two-qubit CNOT operations. In particular, to move quantum information across the cargo elements 1306a-1306f through

the spin chain 1300, the quantum I/O module 602 applies an alternating pulse sequence of $\hat{A}\frac{NOT}{1}$ followed by $\hat{B}\frac{NOT}{1}$, while the generation of a control-U between two neighboring logical qubits requires a predetermined number of global pulses. The application of the above two pulse sequences results in a quantum CNOT gate within the QIP element 1304a. In a preferred embodiment, the global addressing pulses include electromagnetic field pulses that interact with the qubits. In another illustrative embodiment, ENDOR includes the values of the pulses."

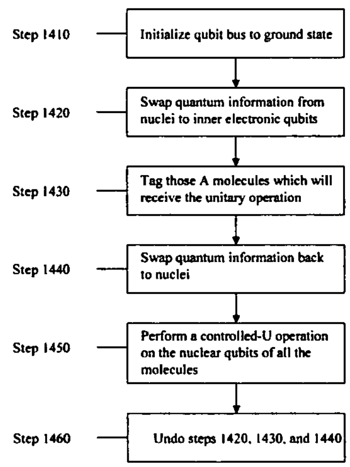

Figure 14

"**0134** Figure 14 is a flow diagram depicting exemplary steps performed by the quantum processor of Figure 6 to perform quantum operations. The first step 1410 involves initializing a local qubit bus 1352 to ground state. In a preferred embodiment, the qubits exist within QIP elements 1304a-1304f. In another embodiment, the qubits exist in joined QIP elements 1304a-1304f according to the method of Figure 10. In one illustrative embodiment, the quantum information is stored in the electron spins of the cargo elements 1306a-1306f. In another illustrative embodiment, the quantum information is stored on the nuclear spin of the cargo elements 1306a-1306f. In one illustrative embodiment, this initialization occurs with a spin cooling quantum algorithm to spin cool all of the nuclear and electron spins to the ground state. In another illustrative embodiment, initialization occurs with spin initialization imposed by an external magnetic field."

"**0135** Referring again to Figure 13, to execute a unitary operator, the inner cargo elements 1306b-1306e become a local "bus" 1352 for the quantum information stored in the nuclei of the cargo elements 1306a-1306f that act as qubits. In the illustrative embodiment, the cargo elements 1306a-1306f are molecules whose electron or nuclear spin represent quantum information including qubits. In the illustrative embodiment, the algorithm begins in step 1410 by initializing the bus 1352 to the ground state of a cargo element including nuclear spin as a qubit. Because the nucleus is presumed to be a fermion, it possesses ground state spin denoted by $|m_s\rangle = |-1/2\rangle$ for all of the molecules 1306b-1306e that exist in the bus 1352. According to the illustrative embodiment, this initialization occurs with a spin cooling quantum algorithm to spin cool all of the nuclear and electron spins to the ground state. In a particular embodiment, application of RF waves mediate the spin cooling. Subsequent to the initialization, an arbitrary pattern of quantum information is written onto the nuclear spins of the A and B molecules 1306a-1306f within the clathrin cages 1304a-1304f, respectively. The quantum processor 602 then swaps 1420 the quantum information of the first cargo element 1306a from the nuclei to the electron of the first molecules in the local bus 1306b. In the illustrative embodiment, the swap operation 1420 is performed using multiple CNOT operations using the method described with respect to Figure 11. The quantum computer 600 then tags 1430 the first cargo element 1306a receiving the unitary operation U in $\hat{A}\frac{U}{f}$ by performing a spin-flip on all of the electrons in the bus 1352 in the where the state of neighboring electrons exists in an opposite quantum logic state. The quantum computer 600 then undoes the swapping step 1420 by swapping 1440 the quantum information back into the nucleus of the last cargo element 1304f from the electron of the last cargo element 1306e of the local bus 1352. The quantum state of the information transmission is inferred from the state of the last cargo element 1304f."

0136 The quantum computer 600 then performs a controlled-U operation 1450 on the nuclear qubits of all of the cargo elements 1306a-1306f within the QIP elements 1304a-1304f using the electron qubits of the molecules in the bus 1352 as a control. In

one embodiment, the quantum processor performs the controlled-U operation essentially as discussed referring to Figure 13. In step 1460, the quantum computer 600 undoes the previous steps to initialize the QIP elements 1304a-1304f for the next global operation 1400. Thus, the quantum processor 602 swaps the information from the nucleus to the electron on the first cargo element 1306a, undoes the tagging 1430 of the adjacent molecules 1306b-1306f, respectively, and then swaps 1440 the quantum information back from the electron of the last cargo element onto the nucleus of last cargo element 1306f. The quantum processor 602 consequently re-initializes the system in the manner described above after performing the global operation $\hat{A}\frac{U}{f}$.

E.6. In summary, none of the above USPTO cited references in **C2-C3** discuss concrete implementation details like those set forth in the instant patent application specification. Moreover, the various cited authors do not even contemplate constructing an actual quantum computer that has novel utility, as is expressed in the instant application and, as noted above, in the amended claims. The USPTO has failed to prove its case that its cited references to natural tobacco mosaic virus in **C2-C3** can actually be used to construct a quantum computer, theoretically or practically and or as controlled source of photons for enabling these QIP elements.

Accordingly, the USPTO rejection of claims per **C2-C3** in the instant patent specification is based on conjecture and theoretical speculation.

E.7. The natural self-assembly mechanics of bio-structures, which is listed as one basis for USPTO rejection of some claims (**see C1-C3**), is, in fact, a basic feature of nearly all bio-systems from the nanoscale to the macro. There is ample and lengthy precedence of the USPTO awarding numerous patents for inventions that utilize natural self-assembly for forming structures like vesicles and other self-assembling frameworks.

As an example, the following recently issued patents all utilize natural self-assembly to form various kinds of biological structures, including vesicles, etc., and which are also listed on a separate Information Disclosure Statement, attached. (A simple search will show hundreds of USPTO issued patents that utilize natural self-assembly to produce manifold structures, including cavities, etc.):

7,112,330, Method for producing yeast expressed HPV types 6 and 16 capsid proteins, Buonamassa, et al., September 26, 2006

7,105,303, Antibodies to hepatitis C virus asialoglycoproteins, Ralston, et al., September 12, 2006,

7,094,409, Antigen arrays for treatment of allergic eosinophilic diseases, Bachmann, et al., August 22, 2006

RE39,229, Binding proteins for recognition of DNA, Choo , et al., August 8, 2006 (NOTE: This particular patent is attached hereto as it is uncertain about origin country of filing.)

7,060,291, Modular targeted liposomal delivery system, Meers, et al., June 13, 2006

7,063,860, Application of lipid vehicles and use for drug delivery, Chancellor, et al., June 20, 2006

7,048,949, Membrane scaffold proteins, Sligar, et al. May 23, 2006.

A distinguishing and defining characteristic of the above (herein incorporated as reference and listed on a separate document) and other patented systems using self-assembling bio-structures is the clear evidence of the intervening hand of man, without which these patented bio-structures would not have been possible, nor would they have specific, novel, and artificial utility. For example, novelty and utility are expressed in the amended claims in the instant application, which make repeated use of terms such as "artificially-induced self assembling purified Clathrin protein molecules", "precise control over its fabrication", "man-made" "calculatedly", and "non-naturally occurring". The instant invention is sui generis; a non-naturally occurring, unique nano-bio-system. This was seen in section A, above. It's also expressed in the amended claims.

Thus, there is ample patent precedence that self-assembly of bio-systems with complex internal structures that closely mimic natural systems is patentable so long as they have novel utility and show the hand of man, like the instant application. Using this self-assembling feature as the basis for rejection by the USPTO of claims in the instant application is therefore without merit.

E.8. Similarly, the USPTO argument as used in **C2-C3**, above, is undone by precedence because a simple search will show there are many USPTO issued patents that include or utilize well-known bio-material compositions, like liposomes, capsids, and viruses as the basic feature of the invention and thus could have been said to be anticipated by the teachings of others. In all these issued patent cases, combining various liposome, capsid, and virus teachings could have been used by someone or a person who had ordinary skill in the art at the time to create the materials used in the inventions listed in the below virus-related and liposome-related and capsid patents, which are herein listed on a separate document as references to the instant application specification:

7,118,740, Method for limiting the growth of cancer cells using an attenuated measles virus, Russell, et al. October 10, 2006.

7,118,738, Recombinant pox virus for immunization against MUC1 tumor-associated antigen, Schlom, et al. October 10, 2006

7,112,337, Liposome composition for delivery of nucleic acid, Huang, et al. September 26, 2006.

7,108,863, Liposome composition for improved intracellular delivery of a therapeutic agent, Zalipsky, et al. September 19, 2006.

7,101,570, Liposome compositions and methods for the treatment of atherosclerosis, Hope, et al. September 5, 2006.

7,101,532, Liposome containing hydrophobic iodine compound, Aikawa, et al. September 5, 2006

7,037,520, Reversible masking of liposomal complexes for targeted delivery, Smyth Templeton, May 2, 2006

7,033,834, Methods and means for targeted gene delivery (using viral capsids) Valerio, et al. April 25, 2006.

All the above patented inventions use well-known biomaterials, and their inventors also had knowledge of the teachings of others to create their inventions, as is obvious to anyone skilled in the art. But the use of well-understood bio-building blocks did not negate the unique and individual utility of each of these inventions. Once again, USPTO precedence shows that novel utility outweighs any purported anticipation based

on other teachings. The instant invention is sui generis, which is expressed in the instant application specification and amended claims, which make use of terms such as "artificially", "calculatedly located within the man-made cavity", and "non-naturally occurring laser light source offering precise control over its fabrication and operation", and other such to express that this is a novel invention with specific asserted utility.

E.9. Finally, it has been shown that simply combining or singly using Fujime's and Namba's teachings about naturally occurring tobacco virus and laser light to create a viable photonic quantum computer element and ARC laser light source is not feasible and effectively unworkable, for all the reasons listed in sections C through E above.

F. Per 35 U.S.C.103 (a), and 37 C.F.R. 1.56, and potential 35 U.S.C.102 (e), (f), or (g) prior art under 35 U.S.C. 103(a), re commonly owned claims, all claims in the instant patent are commonly owned by Franco Vitaliano and Gordana Vitaliano

G. Re other Art, Journal Articles, etc., it should be noted that F. Vitaliano's article, "The Next Big Thing That Will Change Absolutely Everything," (2001) was a general information article that did not describe in any detail whatsoever the instant invention.

Re F. Vitaliano's "VXMaia: A New Quantum Computing System" (PowerPoint presentation, June 18, 2002), this was a closed-door, highly secure briefing to the DOD and was not intended for distribution or publication.

Re F. Vitaliano's "VXMaia: A New Quantum Computing System for Biotech" (PowerPoint presentation, October 23, 2002), this was a closed-door presentation done under NDA and was not intended for distribution or publication.

Lastly, F. Vitaliano's "ExQor: A New NBIC Platform" (PowerPoint presentation, September, 2003), was also a closed-door presentation and was not intended for distribution or publication, and in addition, it was done after filing of the instant patent on September 13, 2003.

All other listed documents have no specific bearing in any way on the instant application and are viewed as being background information, only, as they do not specifically teach how to create bio-engineered laser light source elements and systems

with ARC characteristics using bio-engineered clathrin protein, which also have utility in quantum information processing.

Date: November 16, 2006

Filed Pro Se

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